THE NON-DESTRUCTIVE ANALYSES OF SOME ANCIENT PERSIAN ARTIFACTS

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I. INTRODUCTION

The basis for this report are the analyses of materials found as beads at the Iranian archeological site of Tall-i-Malyan (ancient Anshan). These analyses are by no means an exhaustive study of the materials; rather, they form a preliminary classification designed to uncover those areas where it would be profitable to do more work in the future.

Petrological and mineralogical studies have been of value in the field of archeology for the determination of source areas for the various materials which were involved in trade. Once the source area for a material is known with some certainty, it is possible to reconstruct ancient patterns of trade. Analytical studies of ancient synthetic and naturally-occurring materials have also been useful in the study of the development and spread of ancient technology.

Malyan is located in the Iranian district of Fars in the southern Zagros Mountains, approximately 46 kilometers north of Shiraz (Map 1). The University Museum of the University of Pennsylvania has sponsored three seasons of excavations directed by Dr. William Sumner of the Ohio State University Anthropology Department.

Occupation of this site dates from the fourth millenium B.C. to 500 B.C. The materials described below are from three occupation levels. The periods and dates of these occupations are: the Banesh Period (c. 3000 B.C.), the Kaftari Period (c. 2000 B.C.), and the Middle Elamite Period (c. 1200 B.C.) (Sumner 1973).

II. METHODOLOGY

The nature of the materials studied dictated that only non-destructive analytical methods be used. The classification of the materials is thus based mainly on their appearance. The binocular microscope was the primary tool used in this work. In addition to the microscope, X-ray analysis of one sample was available, and the scanning electron microscope was used for a probe analysis of one ceramic bead.

Although none of the beads have "fresh" surfaces, some had been broken in the past, giving an indication of the cleavage, fracture pattern, texture, and luster of the raw material. In some instances, the combination of the worked surface of the material and a calcium carbonate coating made determination of exact lithologies impossible. The nature of the polish on the beads did prove somewhat useful in the determination of hardness, however. In general, the harder materials have a higher polish and retain more abrasive scratches than the softer materials. The latter relationship is probably due to the increased wear of the softer materials during use. The organic materials present show specific structures (e.g. pores) which distinguish them from the minerals and rocks.

III. CLASSIFICATION, DESCRIPTION, SOURCE AREAS

The complete classification of the beads is summarized in Table 1. Roughly 85% of all bead materials studied fall into five major categories. These are: talc, bitumen, carbonates, silica, and synthetic materials. These categories will be more fully described below.

Three types of talc occur among the artifacts studies. The most distinctive of these is a massive red variety.[1] This type contains abundant, small (less than 0.5 mm) crystals of hematite interspersed with and cut by veins of gray talc. The color ranges from a solid dark red to red and green mottled as the amount of visible hematite decreases. A light green foliated talc also occurs, but with less frequency than the red talc. The third material to fall in the talc category has been labelled "steatite" for the purpose of classification. The actual mineral content of this material is not precisely known. It has a relatively uniform gray color and a greasy luster. This material is massive and appears to be soft, but not brittle.

Among the igneous rocks of Iran are many ultrabasic regions which may be sources of talc (Map 1). A review

[1] Determined by X-ray diffraction analysis. (Personal communication, M. Blackman)

of the available literature has revealed no references to red talc among artifacts found at other Iranian sites. If the occurance of this material is unique to Malyan the source area is likely to be close to the site. The "steatite" may be a form of chlorite, or a chlorite-indurated talc, both of which occur in significant quantities near Yahya (Beale 1973).

An unspecified type of solid hydrocarbon is the single most common bead material among those studied. Following the classification used by Forbes (1936), this material has been labelled "bitumen."[2] The bitumens are a dark brown to black in color. They show a conchoidal fracture and a resinous luster. Broken surfaces are often very irregular, indicative of brittleness. The Iranian and eastern Mesopotamian surface deposits of bitumen are shown on Map 2.

The carbonates among the collection of beads are travertine, marble, and limestone. The travertine varies in color from an opaque white to a translucent honey brown. It show fine banding and a regualr fracture. There are two distinctly different varieties of marble among the Malyan materials. The more common variety is medium-grained and salmon-colored, containing minute crystals of magnetite. The other variety (occurring only once) is fine-grained, mottled brown and white, with

[2] "Bitumen" includes the asphalts and asphaltites. Chemical tests are necessary for specific classification.

white veins dissecting the brown areas. Limestones occur infrequently among the beads and will not be described here except to note that Iran has widespread deposits of limestone (Map 1).

Deposits of travertine occur along the major igneous zones in northern and central Iran (Maps 1 & 3). Marble occurs in a few places in Iran (Map 3), but descriptions of the marbles from the known sources are not available at this time.

Silica occurs among the artifacts most commonly in the form of carnelian. The carnelians vary in color from a light yellow to a deep red. Most are of a single color, but banded varieties also occur; these are typically in shades of white, yellow, red, and brown. Occurring much less frequently are "rock crystal," agate, and unworked, river-abraded pebbles of quartz or quartzite.

The source of Iranian carnelian is not known with any degree of accuracy. The only documented Iranian source is an alluvial deposit near Shar-i-Sokhta (Beale 1973). It is also possible that the carnelian came from India, where mineable deposits occur.

The synthetic materials found as beads are ceramic and glass. The ceramics have been subdivided into three categories. The first, a brown variety, is unglazed. This material appears to have been originally composed of mud or clay, with sand-size grains of various minerals throughout. Another material, which was apparently used unglazed, appears to be entirely composed of a white clay. This ceramic has a very even texture and a chalky feel. The third category includes all those ceramics which were glazed. Four of the beads in this category retain only traces of the glaze so that the underlying material can be easily seen. This material seems to be composed of a white clay and medium-sized grains of quartz sand. It usually has a pitted, irregular surface. The remaining beads in this category have a sufficient covering of the blue or green glaze to obscure the nature of the underlying material. These samples show both vitreous and matte glazes. A scanning electron microscope probe of one of these beads showed that the underlying material is largely composed of silicon, possibly in the form of quartz or quartzite. The glaze contains significant amounts of copper, iron, silicon, aluminum, potassium, and sodium. The coloring agent in the glaze is probably the copper, while the other constituents form the glass.

Synthetic glasses are not common among the beads, but their occurence is significant as an indication of the technology of ancient Iran. All of the glasses show some degree of weathering. Some show only an irridescent luster, while others have lost nearly all resemblance to glass, consisting of layers of a pearly white weathering product. The degree of weathering does not correspond directly with the age of the glass. Assuming uniform conditions of burial for all of the samples, the differences in weathering rates must be due to differences in composition. The more severely weathered pieces are probably those containing the greatest percentage of soluble alkali flux. (Laubengayer 1931)

IV. CONCLUSIONS

A statistical analysis of the data contained in Table 1 was not attempted due to the lack of sufficient data to make such an analysis meaningful. At this point, any generalization concerning the change in the use of materials through time would be entirely speculative. Forthcoming seasons in the field and additional material analysis should provide enough data to make such a study possible in the future.

The data for the Banesh Period can, however, be fitted into the trade network which is believed to have existed in the third millenium. The occurence of lapis lazuli in particular indicates that Malyan was a part of that trade network. There are no known sources of lapis lazuli in Iran. The lapis found as artifacts at Iranian sites is thought to be derived from the Badakshan region of northern Afghanistan (Hermann 1968). The occurence of lapis lazuli artifacts in the major third millenium Iranian sites was used by Maurizio Tosi (1974) to reconstruct the patterns of trade which existed in the third millenium.

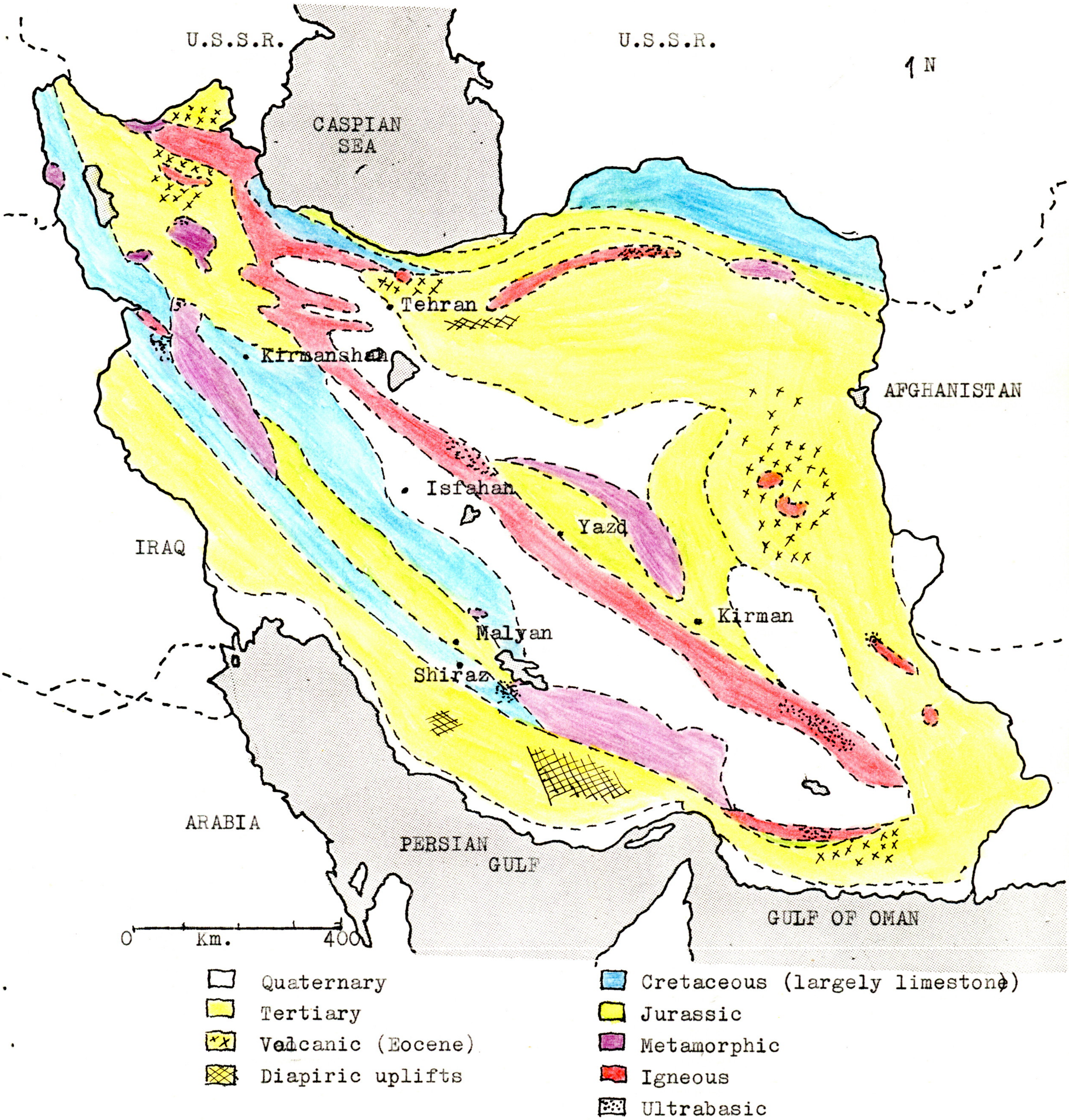
Taking Tosi's map as a base and superimposing the possible source areas for the other materials used in bead manufacture, it was found that many of the source areas lie near the major sites or along the hypothetical trade routes (Map 4). In particular, documented sources of carnelian and bitumen coincide with the sites of Bahrein and Shar-i-Sokhta, while Yahya is a known source of marble and "steatite." Whether the materials found at these sites actually entered the main trade circuit (hence to Malyan) can only be determined when good descriptions of the source areas become available.

Although there is a general paucity of petrological descriptions of most Iranian deposits of these early commercial minerals, Forbes (1936) has published chemical analyses of the bitumens of the Near East. Where analyses of the bitumens found at Malyan carried out, they should prove to be of immediate value in the determination of source areas.

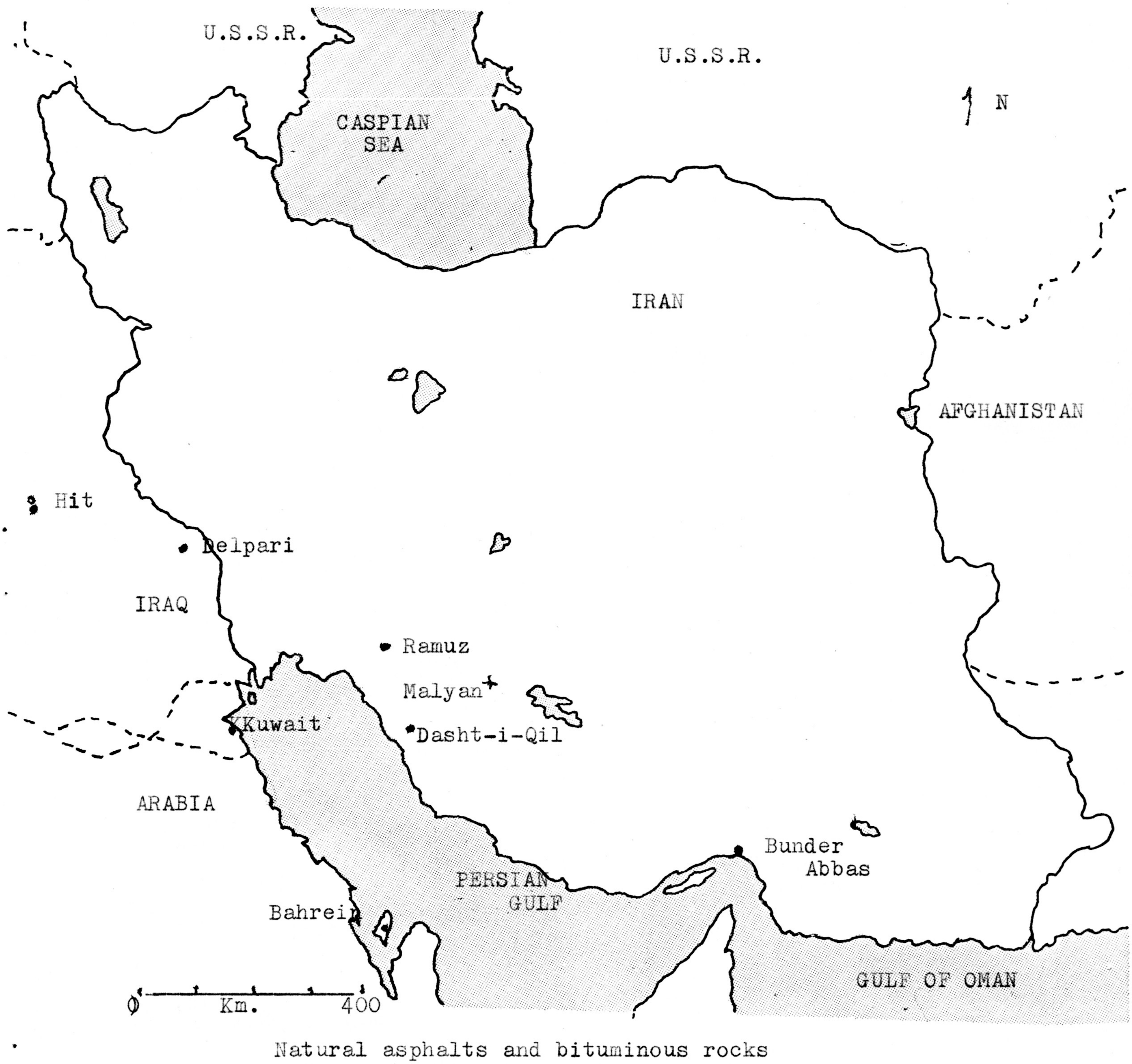
MATERIAL	BANESH 3000 BC	KAFTARI 2000 BC	MIDDLE ELAMITE 1200 BC	PERIOD UNKNOWN
red talc		3	1	1
green talc	2			3
steatite	11	2		1
bitumen	61*			1
serpentine	1	2		
shell	2		1	
limestone	1	2	1	
travertine	6	2		1
marble	2		1	1
bone	1			
malachite	2			
lapis lazuli	5	3	1	3
hematitic sandstone		1		
basic igneous	2			
carnelian	3	5	2	9
agate				1
quartz crystal	1			1
quartzite pebble		1		1
brown ceramic	1		1	
white ceramic	2			4
glazed ceramic	3	4		
glass	1	1		3

*Reflects one find of 56 beads

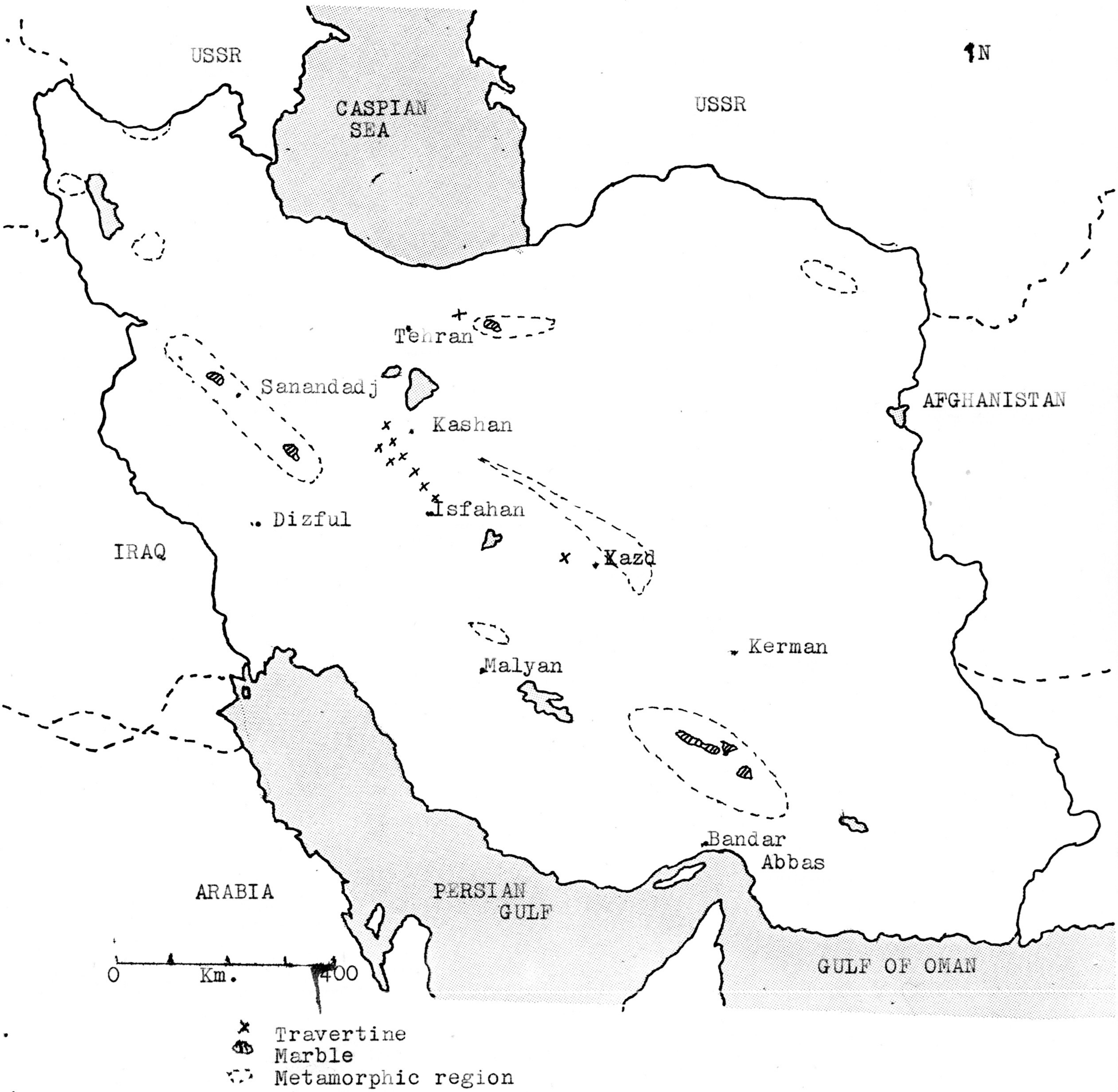
TABLE 1. Bead classification



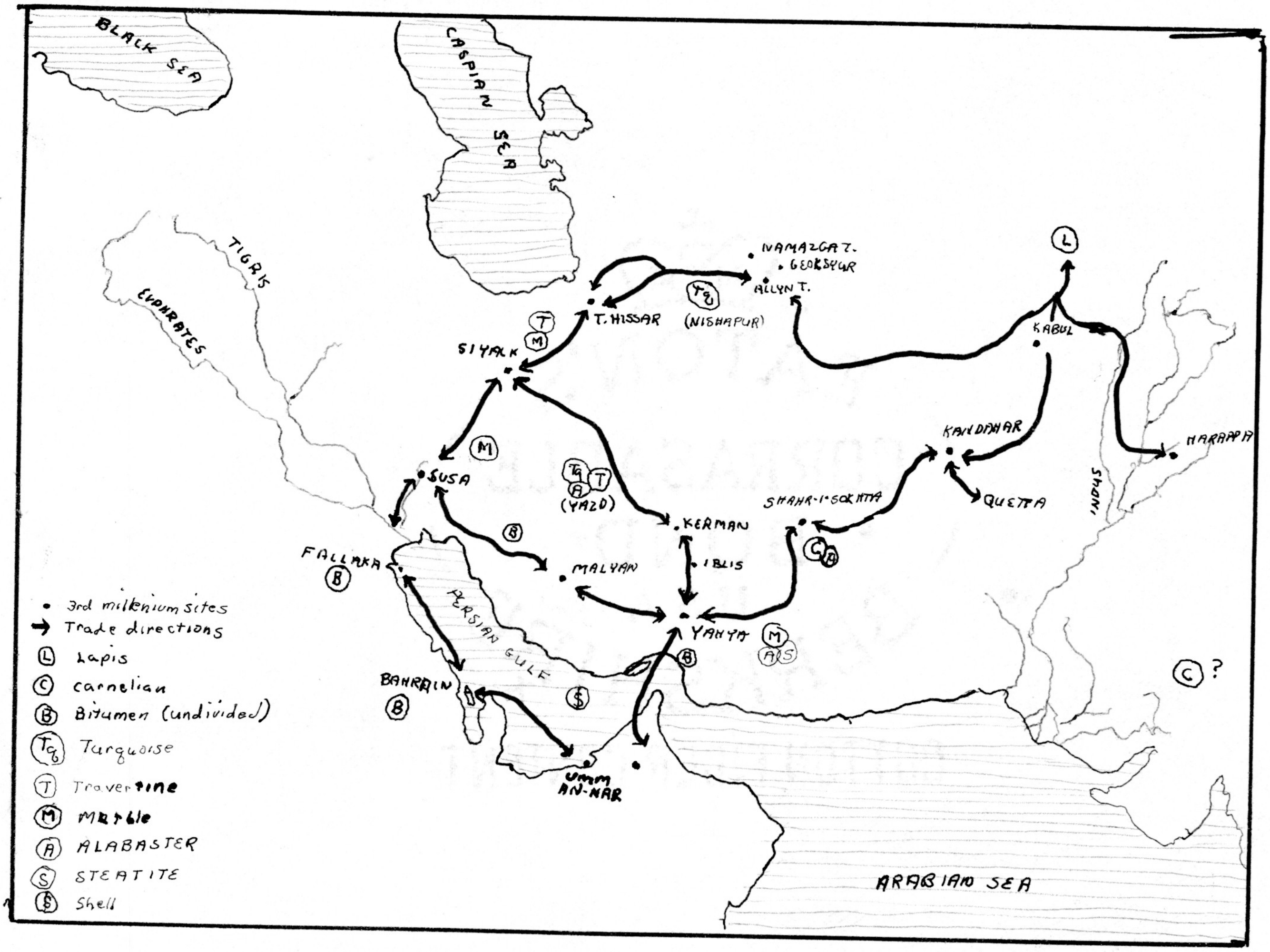
MAP 1. Geology of Iran (After Iranian Oil Company 1957)



MAP 2. Bitumen distribution in Iran. (After Forbes 1936)



MAP 3. Iranian marble and travertine localities. (After National Iranian Oil Company 1957)



MAP 4. Trade routes and mineral deposits of the third millenium B.C. (After Tosi 1974).

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